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Management of Abdominal Wounds in Thermally Injured Patients

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Over a 10-year period, 103 burned patients (mean age, 25 years; mean burn size, 43% of the total body surface) required an intra-abdominal operation. Life-threatening complications dictated operative intervention, and the complications resulted in increased mortality. Abdominal incisions dehisced in 33 patients. In 75 patients whose 91 incisions were closed with retention sutures, 18 wounds (20%) separated postoperatively, including seven in which synthetic sutures disrupted. In 28 patients whose 35 abdominal incisions were closed without retention sutures, 15 wounds (43%) dehisced. Placement of the abdominal incision through the burn wound appeared not to affect the incidence of dehiscence. When an abdominal operation is required in burned patients, their wounds should be closed by stainless steel wire, usually as retention sutures, placed through all muscle and fascial layers of the abdominal wall.

Although abdominal wound closure can usually be carried out safely and without incident on otherwise healthy patients, a frequent and major complication of intra-abdominal surgery in patients with severe thermal injuries is wound failure with dehiscence and evisceration. Many of the factors detrimental to effective wound healing are often present in these patients: bacterial contamination (and frequently, infection) of the wound, injury of varying depths of the abdominal wall, inability to obliterate wound dead space and close all layers of the wound, compromised tissue perfusion, patient malnutrition, and impaired host defense mechanisms. We have examined our experience with intra-abdominal surgery to determine the incidence of wound failure and to identify means to minimize its occurrence. From these data we present suggestions which we feel will favor successful wound closure and eliminate unwanted results.

MATERIALS AND METHODS

The records of all patients admitted to the U.S. Army Institute of Surgical Research from 1969 to 1978 were reviewed to determine the numbers and outcomes of intra-abdominal procedures carried out during that interval. All extraperitoneal operations were excluded. Specific attention was directed to the incidence of dehiscence, the incision utilized, and the methods of wound closure. Records of patients operated upon in a referring treatment facility were often incomplete; the tabulated results presented here reflect only the data accurately recorded on clinical charts. Dehiscence is defined as the separation of the fascial layers of the abdominal wound with either imminent or actual expulsion of the intra-abdominal contents.

Of 2,980 admissions, 103 patients underwent 149 intra-abdominal procedures. Their mean age was 25 years (range, 11 months to 76 years) and mean total body surface area burn 43% (range, 9.5 to 76%), with an average 21.3% (range, 0 to 73%) surface area of third-degree burn. Eighty-nine per cent of the patients were males. Sixty-five patients died, for an overall mortality rate of 63%.

Although other than descriptive statistics seem inappropriate for characterizing this selected group of patients, the effects of the need for intra-abdominal surgery and of dehiscence on mortality were examined by a binomial probability analysis based on the age and burn size of the over 6,000 patients treated at this Institute since 1950. These results are expressed as predicted deaths and the 95% confidence limits (C.L.) of this prediction. Any mortality prediction lying outside of the confidence limits is assumed to represent a deviation from the expected results.

RESULTS

Indications for Operation. One hundred three patients underwent 149 intra-abdominal operations and,

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except for the 23 feeding gastrostomies, all procedures were mandated by urgent complications of underlying disease (Table I). Twenty-six patients presented with upper gastrointestinal bleeding, 14 with both perforation and bleeding, and ten with perforation alone. Acute inflammatory disease presented as acute appendicitis (two cases), mesenteric adenitis (two cases), and a primary intra-abdominal abscess. The miscellaneous group included diverting colostomy performed elsewhere for perineal burns (four cases), bowel infarction (two cases), colonic bleeding (two cases), large-bowel perforation (two cases), and bowel obstruction (two cases).

Incidence of Dehiscence. Dehiscence occurred in 33 patients (32% of operated patients). Although detected between the third and fourteenth postoperative days, the peak incidence of dehiscence was on the sixth postoperative day (Fig. 1). Dehiscences followed subsequent operations at approximately the same rate as those following the primary procedure in those patients requiring multiple procedures (Table II). Although used in a minority of operations, paramedian incisions dehisced more frequently than midline incisions (44% vs. 21%). Transverse incisions were as secure as midline incisions, with a dehiscence rate of 19% (Table III).

The abdomen was entered through burns in 46 patients; the incisions through second-degree burn dehisced in 12 patients (48%), and through third-degree burn, eight patients (38%). Incisions through unburned skin separated in 13 of 57 patients (23%). However, the mean total area of burn was 50% (range, 18 to 74.5%) of the body surface in the patients with abdominal burns, and only 41% (range, 9.5 to 76%) in those with no such burn. When the 33 patients with abdominal wound disruption were matched for age, burn size, and postoperative disposition with 33 patients undergoing abdominal surgery without wound failure, abdominal incisions were placed through burned skin with the same frequency in each group (Table IV).

Method of Closure. Most primary abdominal incision closures included the use of sutures to approximate the fascial edges. Eighteen dehiscences occurred in 75 patients (24% patient dehiscence rate) who had their 91 abdominal wounds reinforced with retention sutures (20% wound dehiscence rate; Table V). In the 28 patients whose 35 incisions were closed without retention sutures, dehiscence ensued on 15 occasions (43% wound dehiscence rate). Ten patients had their original incisions closed only with retention sutures and three of these dehisced. However, no dehiscences took place in any of

TABLE I
Indications for primary operation

Curling's ulcer	50
Enteral feeding	23
Abdominal trauma	5
Acute inflammatory disease	5
Superior mesenteric artery syndrome	4
Biliary tract disease	4
Miscellaneous	12
Total	103

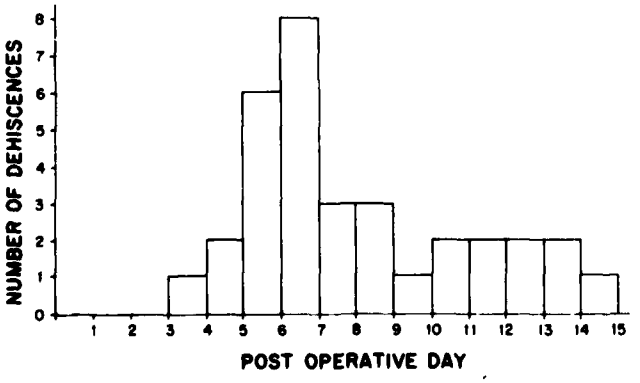

FIG. 1. Postoperative appearance of wound dehiscence, with peak incidence at the sixth postoperative day.

TABLE II
Relationship of sequence of operations to incidence of dehiscence (103 patients)

	No. of Operations	No. of Dehiscences	(%)
First*	106	25	(23)
Second	34	6	(17)
Third	6	1	(17)
Fourth	2	1	—
Fifth	1	0	—

* Includes three patients with two separate abdominal incisions.

TABLE III
Effect of incision on incidence of dehiscence

Incision	No. of Operations	No. of Dehiscences	(%)
Midline	108	23	(21)
Transverse	32	6	(19)
Paramedian	9	4	(44)

TABLE IV
Comparison of two patient groups matched for age, burn size, and postoperative disposition

	With Dehiscence	Without Dehiscence
No. of patients in each group	33	33
No. of incisions through burns	10	10
No. of deaths observed	25	24
No. of deaths predicted	14	14
(95% C.L.)	(10–18)	(10–18)

C.L.—Confidence limits.

TABLE V
Effect of retention sutures on incidence of dehiscence

Closure	No. of Closures	No. of Dehiscences	(%)
With retention sutures	91	18	(20)
Without retention sutures	35	15	(43)

the 23 patients with previously dehisced wounds, all of which were closed with only retention sutures (these patients are not included in Table V).

Because so few closures utilized any suture material other than stainless steel wire, no broad generalizations can be made about the effect of suture composition on wound failure. However, on the limited occasions when stainless steel wire was not used for fascial approximation, wound complications frequently developed. When polypropylene was used for fascial closure, the wound disrupted on four of five occasions because the suture material became untied or broke at the knot. Retention sutures were not employed in these patients. Of the 11 patients whose fascial layers were closed with catgut, six dehisced, including all four patients without retention sutures. Of the five patients whose incisions did not dehisce, four were closed with retention sutures and the other had undergone a colostomy closure after the burn had healed. Rupture of synthetic monofilament retention sutures was associated with dehiscence in seven of 18 patients whose abdominal incision closure employed this technique.

The skin incisions of 26 surgical wounds through unburned skin were closed primarily; there were no dehiscences and only two superficial wound infections, which were effectively treated by removing the skin sutures to allow drainage. The mean burn size of this group of patients was 34% TBS (range, 9.5 to 62.5%), and the lesser extent of burn may be related to the lack of wound failure in this group. Seven skin wounds through burned skin were closed primarily, with two dehiscences and one severe wound infection. The placement of drains did not seem to influence wound integrity.

Factors Affecting Survival and Wound Failure. Sixty-five of the 103 patients requiring abdominal surgery died, for a mortality rate of 63%. Based on age and burn size alone, the number of deaths expected in a group of this size is 33 (95% C.L., 24 to 41), almost half the observed rate. Clearly, the underlying condition necessitating surgical intervention increased mortality in these patients. Seventy-six per cent of the patients with dehiscence died; only 57% of patients without dehiscence died; this added complication seemed to increase mortality. However, if the patients with dehiscence are matched by age, burn size, and postoperative disposition to similarly operated patients without dehiscence, the effect of wound disruption on mortality appears to be minimal: 25 deaths in the dehiscence group and 24 in the no dehiscence group (Table IV). The predicted mortality for these matched groups is 14 deaths (95% C.L., 10 to 18), indicating that the patients' underlying condition, not the occurrence of dehiscence, influenced survival.

The effect of prior intestinal perforation and subsequent peritonitis on susceptibility to postoperative wound dehiscence was examined. Perforation occurred in 24 patients with Curling's ulcer and two with cecal distention. Of the 33 patients whose abdominal wounds disrupted, eight had prior gastrointestinal perforation (24%). Of the 70 patients with intact incisions, 18 had gastrointestinal perforation before surgery (26%). Thus, preexisting perforation did not appear to predispose to subsequent wound dehiscence.

No other potential predisposing factors could be correlated with wound failure. Except for the 23 patients treated electively with feeding gastrostomies, the majority of these critically ill patients were equally affected by ileus, sepsis, abdominal distention, and acute pulmonary diseases. Laboratory studies, including serum protein, hemoglobin, and blood urea nitrogen measurements, showed no consistent patterns indicating which patient was likely to experience wound disruption.

DISCUSSION

While wound disruption following elective intra-abdominal surgery is quite rare, usually occurring in less than one per cent of operations in many series, that following emergency surgery in critically ill patients remains high (6, 17). As seen in the present study, patients with severe thermal injuries rank with other poor-risk patients, such as those with malignancy, advanced age, malnutrition, and bacterial contamination, who develop wound disruption. Examination of the clinical courses of these burned patients points out many factors common to other categories of patients at risk of developing dehiscence. Identification of frequently present etiologic factors may permit use of surgical procedures which reduce the incidence of this complication.

Dehiscence occurred after 22% of intra-abdominal operations in our patients (32% of operated patients), a rate comparable to other series of patients with similar underlying conditions (17). It should be noted that 23 of these 103 patients died before the third day following their final operations, and this early mortality may cause an underestimation of the complication in question—dehiscence. Although the earliest dehiscence appeared on the th. following the original operation, the peak incide. etween the fifth and sixth postoperative days (Fig.). These data are similar to those of other large series and suggest that no gross technical errors caused any of the observed wound separations (6, 7, 18). Subsequent abdominal surgery, usually utilizing the prior incision, did not predispose to the development of dehiscence, and this observation suggests that inability of the tissue to heal played a secondary role in wound failure. This concept is reinforced by the absence of dehiscence following closure of previously disrupted wounds, an observation noted in other large series (7, 15). Abdominal incisions made through burned skin were no more likely to dehisce than those made through unburned skin. Unlike patients without burn injuries, stomach and bowel perforations in thermally injured patients apparently do not predispose to a burst abdomen (17). This applies not only to perforations of Curling's

ulcers but also to those associated with cecal volvulus or superior mesenteric artery syndrome (11). In contrast to patients with other forms of severe illness, no systemic (e.g., malnutrition and sepsis) or locally acting (e.g., abdominal distention and vigorous coughing) conditions could be identified which characterized patients susceptible to wound dehiscence (6, 15, 18). However, the severity of the burn injury and its accompanying high incidence of complications and mortality may have obscured factors found by others to predispose to wound failure.

A number of features of the abdominal wound itself were associated with the occurrence of dehiscence. Although fewer in number, paramedian incisions appeared to disrupt more often than either midline or transverse incisions. Both clinical and animal studies indicate that the paramedian incision is the weakest of the three commonly used incisions and, in poor-risk patients, is associated with the highest wound failure rate (18, 24). The use of retention sutures adds strength to wound closures, and in our patients, wounds closed without retention sutures dehisced much more frequently than closures utilizing this technique (43% vs. 19%) (12). The absence of additional sutures approximating the fascial edges did not appear to influence wound integrity. Three of ten wounds primarily closed only with retention sutures dehisced; none of the previously dehisced wounds closed only with retention sutures separated (23 patients). Closure of the peritoneum did not influence wound integrity.

Stainless steel wire was utilized most frequently for incision closure and was found to be generally more reliable than synthetic sutures (5, 10, 21, 23). Sutures of synthetic materials, especially polypropylene, commonly untied or broke at the knot, a recognized limitation of these types of sutures (6). Catgut also was found to be unreliable. It loses its strength early in the postoperative period, long before incision strength has peaked many weeks later (4, 8, 22). This lack of suture integrity is particularly important in thermally injured patients, whose incisions at autopsy, although approximated, frequently showed no evidence of healing as late as the third postoperative week.

In addition to the known biologic deficiencies in wound healing, these considerations suggest that technical factors are major determinants of successful abdominal wound closure in thermally injured patients. Retention sutures effectively reduced the rate of wound dehiscence. In those patients in whom retention sutures failed to prevent dehiscence, many had only a few such sutures spaced widely apart along an extensive incision. All dehisced wounds were reclosed with multiple retention sutures inserted far from the wound margins and placed close together. That none of these wounds separated in spite of having previously dehisced suggests technical failure as a cause of the initial wound disruption. Studies in animal models have documented that an abdominal incision elongates in the immediate postoperative period, thus expanding the distance between sutures (9). Further, sutures placed near the wound edge encompassing only small amounts of tissue often pull through the tissue (19). Both of these events predispose the wound to disruption. Mass sutures, placed 1.5 to 3 cm back from the wound margin and approximately 1 to 1.5 cm apart so as to include all fascial layers and adjacent muscle, produce the strongest closure (3, 14, 24). The use of mass sutures in numerous clinical populations has drastically reduced the incidence of dehiscence, regardless of the incision used and the associated clinical conditions (2, 5, 16, 21). Variations in the insertion technique of mass sutures include simultaneous approximation of the fascial edges, although this can be accomplished with separate fascial sutures according to the surgeon's judgment. Properly placed retention sutures are in effect mass sutures, and their use in our burned patients may reflect the beneficial effects of mass sutures on wound closure. If retention sutures are used to reinforce a fascial closure, they should be placed at intervals of 2 to 3 cm.

When an abdominal operation is required in burned patients, we recommend the following approach. Utilizing either a midline or transverse approach, the incision should be placed to allow the optimal exposure of the suspected underlying pathology, regardless of the presence of burned skin. The fascial incision should be approximated by the mass closure technique, either by classic retention sutures or by exiting the suture through the subcutaneous tissue. The fascial edges are approximated if the wound edges tend to invert. Stainless steel wire is the ideal suture material for these patients and should be used for all tension-bearing sutures. Retention sutures exiting through the skin should be left in place for at least 4 weeks, since healing may be exceedingly slow in some thermally injured patients. The skin incision

FIG. 2. Viable cutaneous allograft is utilized as a temporary dressing. The incision is allowed to close by secondary intention or is closed with autograft after a clean granulation bed has formed.

can be safely closed if it extends through unburned skin. The use of separate sutures to close the subcutaneous space leads to an increased incidence of infection and should not be employed (1). Since the burn wound is often contaminated or infected, any incisions traversing the burn should be left open for delayed closure and covered with allograft as a temporary dressing (20, 25) (Fig. 2).

The high mortality in this group of patients is directly related to the burn injury and the underlying condition requiring operative intervention. The anticipated high number of complications following operation should not deter the treating physician from carrying out the indicated surgical intervention, since patient salvage is improved. By proper attention to the dynamics of incision healing and to technical details, a large proportion of these wound complications can be avoided. Further, certain elective procedures, such as gastrostomy for enteral alimentation, can be carried out in patients with large burns with minimal complications and a very low operation-associated mortality.

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DISCUSSION

DR. BRUCE E. ZAWACKI (LAC-USC Medical Center, Los Angeles, CA 90033): This paper gives helpful and practical advice on a subject that has rarely been addressed in the past. Of all the factors that might be expected to influence wound healing in such circumstances, many we simply can't do anything about, such as the age of the patient, size of the burn, etc. With other factors, such as state of nutrition, the presence of associated infection, and so forth, the surgeon has already been doing everything he can for up until the time of the complication requiring surgery. This paper addresses things he can and must decide about, such as the location of the incision, the type of the incision, and you've heard the authors' conclusions.

It's unnecessary to comment on the obvious problems associated with retrospective studies, or on the fact that such incisions are becoming increasingly uncommon now that major upper gastrointestinal bleeding in burned patients is so rare. But this paper does illustrate an important principle that is applicable with ever-increasing frequency to burned patients. The principle is that operative incisions in patients with large burns seem to require more than the usual time to heal, and more than the usual care to prevent disruption. Currently, the most frequent major operative incision in such patients is that associated with the early excision and immediate autografting of burns. In my judgment, immediate skin graft closure after excision of a large burn is similar to closure of a celiotomy in such patient in that more than the usual time is required for healing and more than usual care is necessary to prevent skin graft failure (which is equivalent to wound disruption). We all know that primarily closed wounds heal much more slowly than granulating wounds closed secondarily; and if we think about it, we might expect a similar lag to occur when we immediately autograft excised burn wounds rather than simply apply graft to granulating tissue. Add to this the apparent delay in wound healing associated with a large burn and it will appear even more reasonable to take more than ordinary care in preventing skin graft disruption in such cases. Rather than the usual 4 to 5 days required for solid adherence when graft is applied to granulating tissue, we have found that up to 10 days of meticulous avoidance of mechanical trauma or contamination is necessary to produce a near 100% take when skin graft is applied immediately after early excision of large burns. Until we recognized this phenomenon and corrected for it, we achieved rather poor, perhaps 50 to 70%, skin graft takes in such wounds. Perhaps this accounts to some extent for the disenchantment I have been recently hearing about the per-

centage of skin graft takes after immediate autografting of primarily excised burn wounds in patients with large burns.

DR. CLEON W. GOODWIN, JR. (Closing): I would like to thank Doctor Zawacki for his comments. I can only reiterate what he has said about the role of poor tissue wound healing in the technical failures of wound closure. Because of the massive thermal injuries and the usually disastrous accompanying intra-abdominal pathology in the patients in our study, it was not possible to separate additional predisposing factors, such as malnutrition, ileus, and pulmonary complications, as contributors to morbidity and mortality.

We had a number of patients who went to autopsy with their abdominal incisions tightly closed but who demonstrated no evidence of healing on removal of the sutures. In addition, underlying intestinal anastomoses, although intact, showed no evidence of healing. For these reasons, we suggest leaving all retention sutures in place for 3 to 4 weeks in the patients whose closures utilize these sutures.